Enclosure 1
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Quality Enhancing Attributes associated with the Engineering Design Subcontractor Power Conversion System Alternatives and Selection Studies

AREVA

- **Original Scope** - AREVA was originally tasked with performing a Power Conversion System (PCS) Alternatives Study (Statement of Work 6306) which would: 1) recommend a configuration of the PCS to be coupled to the primary loop of the high temperature helium cooled gas reactor; 2) evaluate the feasibility issues with the recommended PCS cycle; 3) evaluate the feasibility of an indirect combined cycle gas turbine configurations; and 4) identify PCS configurations for commercial applications including electrical power production and support of hydrogen production.
- **Activities Performed Beyond the Statement of Work** - In addition to this work scope defined in the Statement of Work, AREVA also performed a preliminary safety assessment of water ingress (see Section 3.2.2 of the AREVA Report). This assessment first defines the potential sources of water ingress in High Temperature Reactors (HTRs) based on operating conditions and operational history with the various water ingress accident categories also presented. Consequences associated with the main water ingress consequences are described: primary coolant pressure increase, reactivity and power effects, graphite oxidation, fuel hydrolysis, fission product mobilization, and investment risk. Based on these consequences, the assessment focuses on the available mitigation options through detection, isolation and recovery systems as well as reactor and steam generator designs. Limited scoping calculations of the event, including a RELAP5-3D model and reactivity assessment follow. This evaluation then presents a safety and risk evaluation of the event concluding with additional recommended analysis and R&D in order to further minimize concerns of water ingress in a subcritical steam-Rankine PCS.
- **Importance of the Additional Work** - This analysis provides an initial safety perspective of the potential issues that will need to be evaluated in further conceptual design activities and supports the required integration of safety requirements early in the design process. This additional work provides valuable information for the AREVA and General Atomics reference configuration, where the steam generator is located in the primary loop and the reactor outlet temperature is 750-800°C, chosen for the NGNP as has been recently discussed and evaluated within the Senior Advisory Group working meetings.
- **Impact on Future Work** - This additional work scope performed by AREVA allows the NGNP Project to plan and perform the recommended analysis and R&D to further minimize potential Nuclear Regulatory Concerns of water ingress in a subcritical steam-Rankine PCS. This additional work also sets the stage for conceptual design work identified in both AREVA and General Atomics' Conceptual Design Work Plans where a steam generator in the primary loop is chosen as the reference configuration.

General Atomics

- **Original Scope** - General Atomics was tasked with performing a Power Conversion System (PCS) Alternatives Study (Statement of Work 6301) which would: 1) Provide a recommendation for the configuration for the configuration of the PCS for the NGNP and the justification for this recommendation; 2) Provide estimates of the performance, cost, and design and technology readiness of the PCS configuration recommended for NGNP; 3) Evaluate the feasibility of applying a combined cycle configuration in an indirect heat transport configuration in NGNP; and 4) Identify Configurations of the PCS that should be considered for commercial applications including, as a minimum, electric power production, co-generation and support of hydrogen production.

- **Activities Performed Beyond the Statement of Work -** In addition to this work scope, General Atomics (Toshiba) also performed a detailed evaluation of a printed circuit type compact intermediate heat exchanger (PCHE) based on the Heatric design in the Phase B conceptual design study (see Toshiba Report ECS-AF-200589 which is part of the General Atomics Final Report). This evaluation included a detailed evaluation of a PCHE module, preliminary stress analysis to estimate the effect of thermal stresses on the PCHE lifetime, and an updated cost estimate for a full-size PCHE based on these results.
- **Importance of the Additional Work -** This additional work scope greatly enhanced the PCS Alternatives Study by using the information gained on the PCHE to assist with the comparison of direct and indirect combined cycle power conversion systems that was performed as part of the PCS Alternative Study.
- **Impact on Future Work -** This additional work by General Atomics allows the NGNP Project to further evaluate the direct versus indirect power conversion systems which are represented in the two reference configurations. The information gained on the PCHE, although not directly relevant to the reference configuration chosen by AREVA and General Atomics, is directly relevant to the reference configuration chosen by Westinghouse and the work that is currently underway by the NHI. A PCHE has several potential advantages over a typical shell and tube heat exchanger, primarily size and anticipated cost and efficiency.